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(54) Bismuth salts and complexes with nitrogen-free organic diphosphonic acids

(57) There is provided a bismuth diphosphonate compound (by which is meant essentially any salt or complex of bismuth with essentially any nitrogen-free organic diphosphonic acids) wherein the molar ratio of bismuth to diphosphonate components is from 1:0.7 to 1:7. Bleaching and detergent compositions adapted for use in machine dishwashing having reduced silver-tarnishing, as well as good cleaning performance are also provided which contain an oxygen bleach and the bismuth diphosphonate compound. Preferred processes for making the compositions are described.

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MACHINE DISHWASHING COMPOSITIONS

Technical Field

The present invention relates to bismuth diphosphonate compounds and methods of making such compounds and their use in oxygen-bleach containing compositions, adapted for use in machine dishwashing, which exhibit good bleachable stain removal and reduced silver-tarnishing properties.

Background to the Invention

Compositions designed for use in automatic dishwasher machines are well known, and a consistent effort has been made by detergent manufacturers to improve the cleaning and/or rinsing efficiency of said compositions on chinaware, glassware and silverware, as reflected by numerous patent publications.

The satisfactory removal of bleachable soils such as tea, fruit juice and coloured vegetable soils, such as carotenoid soils is a particular challenge to the formulator of a machine dishwashing composition. Traditionally, the removal of such soils has been enabled by the use of bleach components such as oxygen and chlorine bleaches.

A problem encountered with the use of oxygen bleaches, in particular, is the tarnishing of any silverware components of the washload. Chlorine bleaches can under certain circumstances give rise to silver tarnishing, but the problem is significantly less pronounced than that arising from the use of

oxygen bleaches. The level of tarnishing observed with oxygen bleaches can range from slight discolouration of the silverware to the formation of a dense black coating on the surface of the silverware.

The formulator thus faces the dual challenge of formulating an oxygen bleach containing product which maximises bleachable soil cleaning but minimises the occurrence of tarnishing of any silverware components of the washload.

It has been surprisingly found that reduced silver tarnishing as well as good cleaning performance can be achieved through the inclusion in an oxygen bleach containing formulation of certain bismuth diphosphonate compounds. These compounds also demonstrate good 'in product' storage stability characteristics.

It has also been found that the presence of water-soluble sulphate salts surprisingly enhances the silver tarnish inhibition capability of the bismuth diphosphonate compound. In particular excellent results are obtained when a particle, formed for example, by agglomeration methods, comprising both sulphate and bismuth diphosphonate compound components is employed.

To further reduce the occurrence of silver tarnishing, the rate of release of the oxygen bleach is preferably also controlled. The rate of release of oxygen bleach is preferably rapid enough to provide satisfactory cleaning, but not so rapid that tarnishing is enabled.

Compositions having low alkalinity, and in particular those having alkalinity systems including a minor proportion of a metasilicate component are preferred, as are compositions having a pH which is not unduly high.

UK Patent Specification No. 1,586,067 in the name of the Procter and Gamble Company, discloses automatic dishwashing compositions containing bismuth salts to provide protection to china overglaze without any negative glassware iridescence effects. Bismuth diphosphonate compounds are not explicitly described. It is taught therein that chlorine bleaching agents are preferable components of these compositions and specific examples of chlorine containing compositions are given. The use of oxygen bleaches in

such compositions is not disclosed. The problem of silver tarnishing is not addressed by this document, nor is any teaching provided of the use of bismuth salts as silver tarnish inhibition agents.

Summary of the Invention

There is provided a bismuth diphosphonate compound wherein the molar ratio of bismuth to diphosphonate components is from 1:0.7 to 1:7.

There is additionally provided a process for making an alkaline bismuth diphosphonate solution comprising the following steps:

- (i) formation of an alkaline solution containing a diphosphonate species;
- (ii) agitatative addition of a solution containing bismuth ions to said alkaline solution

wherein the amount of bismuth to diphosphonate species corresponds to a molar ratio of from 1:0.7 to 1:7.

Said bismuth diphosphonate solution can be sprayed onto a bleaching composition to form a bleaching product. In a preferred aspect, the bleaching composition also contains detergent components.

There is further provided a process for making a bismuth diphosphonate containing particle by agglomeration of an inorganic salt containing an anion capable of forming a salt, preferably an insoluble salt, with bismuth with an alkaline bismuth diphosphonate solution, and optionally an organic binder, preferably an organic polymeric compound.

There are also provided bleaching and detergent compositions, adapted for use in machine dishwashing methods, containing an oxygen-releasing bleaching system and bismuth diphosphonate compound. In a preferred aspect the detergent compositions contain no phosphate builder compound.

Detailed Description of the Invention

Bismuth diphosphonate compound

According to one aspect of the present invention there is provided a bismuth diphosphonate compound wherein the molar ratio of bismuth to diphosphonate components is from 1:0.7 to 1:7, preferably from 1:1 to 1:6, more preferably from 1:2 to 1:5.

The bismuth diphosphonate compound may be essentially any salt or complex of bismuth with essentially any organic diphosphonic acid. By organo diphosphonic acid it is meant herein an organo diphosphonic acid which does not contain nitrogen as part of its chemical structure. This definition therefore excludes the organo aminophosphonates, which however may be included in any compositions in accord with the invention as heavy metal ion sequestrant components.

The organo diphosphonic acid is preferably a C₁-C₄ diphosphonic acid, more preferably a C₂ diphosphonic acid, such as ethylene diphosphonic acid, or most preferably ethane 1-hydroxy-1,1-diphosphonic acid (HEDP) and may be present in partially or fully ionized form, particularly as a salt or complex.

The compound containing bismuth and HEDP at a 1:3.5 molar ratio is most preferred.

Process for making a bismuth diphosphonate solution

According to another aspect of the present invention there is provided a step-wise process for making a bismuth diphosphonate solution involving sequentially the formation of an alkaline solution containing a diphosphonate species followed by addition of a solution containing bismuth ions. This solution has been found to be both storage and transport stable, and may be employed in the making of bleaching and/or detergent compositions, as described hereinafter.

The advantage provided by the step-wise process versus a process in which both steps take place concurrently is that, in the latter case, a heavy yellow essentially insoluble precipitate, believed to be bismuth hydroxide, is formed. This precipitate impedes the further processing of the solution, and limits its usefulness in the making of bleaching and/or detergent compositions.

The process comprises as a first step the formation of an alkaline solution containing a diphosphonate species. The alkaline solution may for example, be formed by direct addition, preferably with agitation, of a diphosphonic acid to an aqueous alkaline solution, such as NaOH solution. In a preferred aspect said addition is continuous, but carried out at a relatively slow rate such as to avoid excess generation of heat from the neutralization reaction.

The process has as a second step the agitative addition of a solution containing bismuth ions to the alkaline solution containing the diphosphonate species. By agitative addition it is meant addition in the presence of some means of agitation, such as may be provided by carrying out the addition in a mixer apparatus. The solution containing bismuth ions may comprise a solution of any suitable salt or complex of bismuth with essentially any inorganic or organic counter anion. Preferred inorganic bismuth salts for use in making up the solution are selected from the bismuth trihalides, bismuth nitrate and bismuth phosphate. Bismuth acetate and citrate are preferred salts with an organic counter anion.

The amount of alkaline diphosphonate and bismuth ion solutions employed in this process aspect is adjusted such as to result in the formation of a bismuth diphosphonate solution having a molar ratio of bismuth to diphosphonate species of from 1:0.7 to 1:7.

The bismuth diphosphonate solution can be sprayed onto a bleaching composition to form a bleaching product. In a preferred aspect, the bleaching composition also contains detergent components, and the bismuth diphosphonate solution is thus sprayed onto both bleaching and detergent components.

Bismuth diphosphonate agglomerate particle

According to another aspect of the invention there is provided a process for making a bismuth diphosphonate-containing particle by agglomeration of an inorganic salt with an alkaline bismuth diphosphonate solution preferably obtained by the process described hereinabove. The inorganic salt comprises an anion capable of forming a salt, especially an insoluble salt, with bismuth. The advantage provided by the use of an alkaline rather than neutral, or acidic bismuth diphosphonate solution in the agglomeration step is that the undesirable formation of (other) bismuth salts, particularly insoluble ones, is prevented.

The alkaline diphosphonate solution preferably has a pH of at least 9.0, more preferably at least 10.0.

The inorganic salt may be essentially any salt of an inorganic anion capable also of forming a bismuth salt, such as sulfates, carbonates and phosphates with any counter cation, including the alkali and alkaline earth metals. Preferred salts are selected from the sulfates of the alkali and alkaline earth metals, particularly sodium sulfate.

The weight ratio of the inorganic salt to bismuth diphosphonate compound in the particle is preferably from 200:1 to 2:1, more preferably from 100:1 to 5:1, most preferably from 50:1 to 10:1.

In a preferred aspect the particle comprises an organic binder material. The organic binder material is preferably selected from any of the organic polymeric compounds described in detail hereinafter, and any mixtures thereof.

Other suitable binders include the C₁₀-C₂₀ alcohol ethoxylates containing from 5 - 100 moles of ethylene oxide per mole of alcohol and more preferably the C₁₅-C₂₀ primary alcohol ethoxylates containing from 20 - 100 moles of ethylene oxide per mole of alcohol. Polyvinylpyrrolidones with an average molecular weight of from 12,000 to 700,000 and polyethylene glycols (PEG) with an average molecular weight of from 600 to 5 x 10⁶ preferably 1000 to 400,000 most preferably 1000 to 10,000 are also suitable

binders. Cellulose derivatives such as methylcellulose, carboxymethylcellulose and hydroxyethylcellulose, and homo- or co-polymeric polycarboxylic acids or their salts are other examples of binders suitable for use herein.

The agglomeration method employed can be any of those known in the art. Any conventional agglomerator/mixer may be used including, but not limited to pan, rotary drum and vertical blender types. Mixers sold by Schugi (tradename) and Lodige (tradename) for use in agglomeration methods are particularly suitable. Agglomeration processes employing 'in series' combinations of mixers are also envisaged.

Bleaching compositions

The bismuth diphosphonate compounds and particles containing such compounds described hereinbefore may be incorporated into compositions containing an oxygen-releasing bleaching system.

Oxygen-releasing bleaching system

In one preferred aspect the bleaching system contains a hydrogen peroxide source and an organic peroxyacid bleach precursor compound. The production of the organic peroxyacid occurs by an in situ reaction of the precursor with a source of hydrogen peroxide. Preferred sources of hydrogen peroxide include inorganic perhydrate bleaches. In an alternative preferred aspect a preformed organic peroxyacid is incorporated directly into the composition. Compositions containing mixtures of a hydrogen peroxide source and organic peroxyacid precursor in combination with a preformed organic peroxyacid are also envisaged.

Inorganic perhydrate bleaches

The compositions in accord with the invention preferably include a hydrogen peroxide source, as an oxygen-releasing bleach. Suitable hydrogen peroxide sources include the inorganic perhydrate salts.

The inorganic perhydrate salts are normally incorporated in the form of the sodium salt at a level of from 1% to 40% by weight, more preferably from 2% to 30% by weight and most preferably from 5% to 25% by weight of the compositions.

Examples of inorganic perhydrate salts include perborate, percarbonate, perphosphate, persulfate and persilicate salts. The inorganic perhydrate salts are normally the alkali metal salts. The inorganic perhydrate salt may be included as the crystalline solid without additional protection. For certain perhydrate salts however, the preferred executions of such granular compositions utilize a coated form of the material which provides better storage stability for the perhydrate salt in the granular product.

Sodium perborate can be in the form of the monohydrate of nominal formula $\text{NaBO}_2\text{H}_2\text{O}_2$ or the tetrahydrate $\text{NaBO}_2\text{H}_2\text{O}_2\cdot 3\text{H}_2\text{O}$.

Alkali metal percarbonates, particularly sodium percarbonate are preferred perhydrates for inclusion in compositions in accordance with the invention. Sodium percarbonate is an addition compound having a formula corresponding to $2\text{Na}_2\text{CO}_3\cdot 3\text{H}_2\text{O}_2$, and is available commercially as a crystalline solid. Sodium percarbonate, being a hydrogen peroxide addition compound tends on dissolution to release the hydrogen peroxide quite rapidly which can increase the tendency for localised high bleach concentrations to arise. The percarbonate is most preferably incorporated into such compositions in a coated form which provides in product stability.

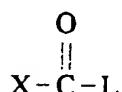
A suitable coating material providing in product stability comprises mixed salt of a water soluble alkali metal sulphate and carbonate. Such coatings together with coating processes have previously been described in GB-1,466,799, granted to Interox on 9th March 1977. The weight ratio of the mixed salt coating material to percarbonate lies in the range from 1 : 200 to 1 : 4, more preferably from 1 : 99 to 1 : 9, and most preferably from 1 : 49 to 1 : 19. Preferably, the mixed salt is of sodium sulphate and sodium carbonate which has the general formula $\text{Na}_2\text{SO}_4\cdot n\cdot \text{Na}_2\text{CO}_3$ wherein n is from 0.1 to 3, preferably n is from 0.3 to 1.0 and most preferably n is from 0.2 to 0.5.

Other coatings which contain silicate (alone or with borate salts or boric acids or other inorganics), waxes, oils, fatty soaps can also be used advantageously within the present invention.

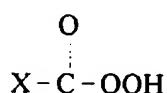
Potassium peroxymonopersulfate is another inorganic perhydrate salt of utility in the compositions herein.

Peroxyacid bleach precursor

Peroxyacid bleach precursors are compounds which react with hydrogen peroxide in a perhydrolysis reaction to produce a peroxyacid. Generally peroxyacid bleach precursors may be represented as



where L is a leaving group and X is essentially any functionality, such that on perhydrolysis the structure of the peroxyacid produced is



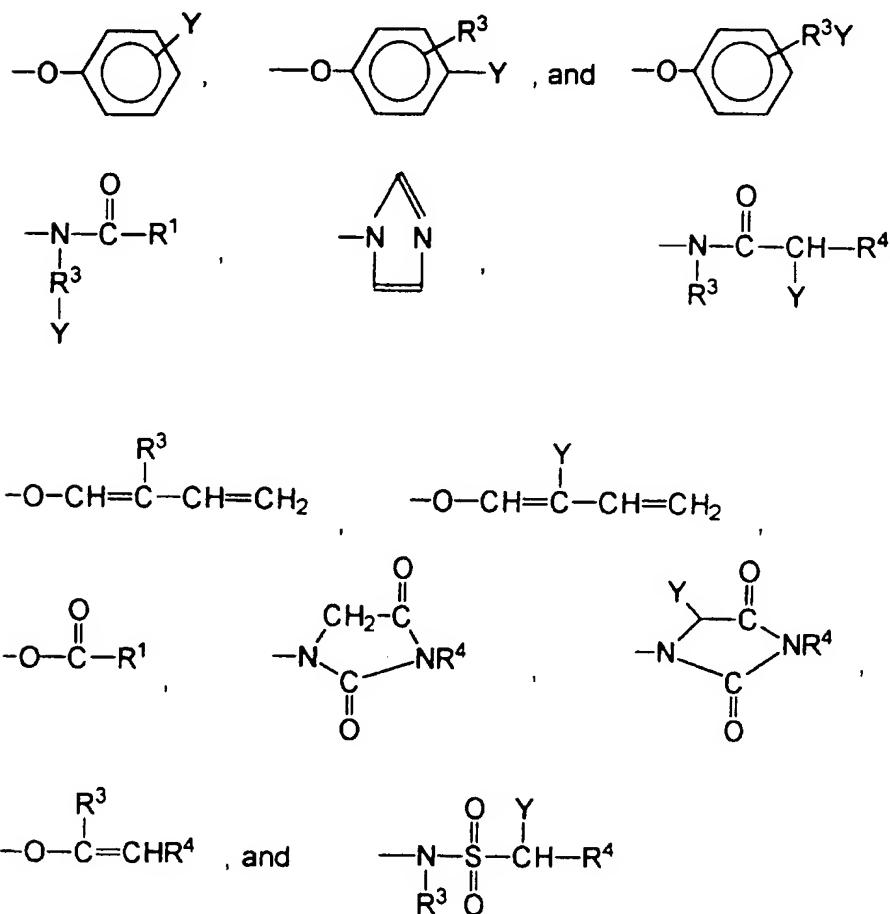
Peroxyacid bleach precursor compounds are preferably incorporated at a level of from 0.5% to 20% by weight, more preferably from 1% to 10% by weight, most preferably from 1.5% to 5% by weight of the compositions.

Suitable peroxyacid bleach precursor compounds typically contain one or more N- or O-acyl groups, which precursors can be selected from a wide range of classes. Suitable classes include anhydrides, esters, imides, lactams and acylated derivatives of imidazoles and oximes. Examples of useful materials within these classes are disclosed in GB-A-1586789. Suitable esters are disclosed in GB-A-836988, 864798, 1147871, 2143231 and EP-A-0170386.

Leaving groups

The leaving group, hereinafter L group, must be sufficiently reactive for the perhydrolysis reaction to occur within the optimum time frame (e.g., a wash cycle). However, if L is too reactive, this activator will be difficult to stabilize for use in a bleaching composition.

Preferred L groups are selected from the group consisting of:



and mixtures thereof, wherein R¹ is an alkyl, aryl, or alkaryl group containing from 1 to 14 carbon atoms, R³ is an alkyl chain containing from 1 to 8 carbon atoms, R⁴ is H or R³, and Y is H or a solubilizing group. Any of R¹, R³ and R⁴ may be substituted by essentially any functional group

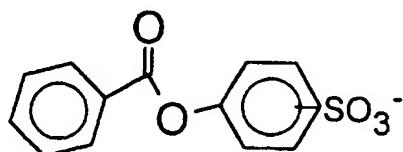
including, for example alkyl, hydroxy, alkoxy, halogen, amine, nitrosyl, amide and ammonium or alkyl ammonium groups

The preferred solubilizing groups are $-\text{SO}_3\text{M}^+$, $-\text{CO}_2\text{M}^+$, $-\text{SO}_4\text{M}^+$, $-\text{N}^+(\text{R}^3)_4\text{X}^-$ and $\text{O}^-\text{--N}(\text{R}^3)_3$ and most preferably $-\text{SO}_3\text{M}^+$ and $-\text{CO}_2\text{M}^+$ wherein R^3 is an alkyl chain containing from 1 to 4 carbon atoms, M is a cation which provides solubility to the bleach activator and X is an anion which provides solubility to the bleach activator. Preferably, M is an alkali metal, ammonium or substituted ammonium cation, with sodium and potassium being most preferred, and X is a halide, hydroxide, methylsulfate or acetate anion.

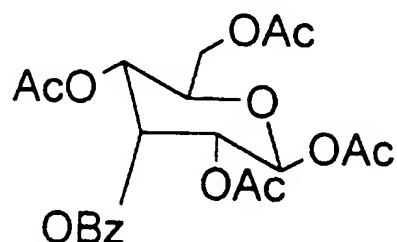
Perbenzoic acid precursor

Perbenzoic acid precursor compounds provide perbenzoic acid on perhydrolysis.

Suitable O-acylated perbenzoic acid precursor compounds include the substituted and unsubstituted benzoyl oxybenzene sulfonates, including for example benzoyl oxybenzene sulfonate:



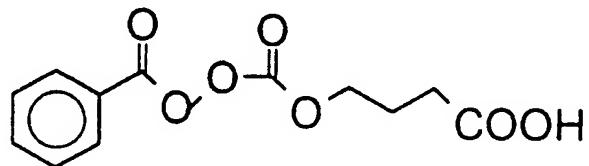
Also suitable are the benzoylation products of sorbitol, glucose, and all saccharides with benzoylating agents, including for example:



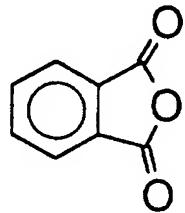
Ac = COCH₃; Bz = Benzoyl

Perbenzoic acid precursor compounds of the imide type include N-benzoyl succinimide, tetrabenzoyl ethylene diamine and the N-benzoyl substituted ureas. Suitable imidazole type perbenzoic acid precursors include N-benzoyl imidazole and N-benzoyl benzimidazole and other useful N-acyl group-containing perbenzoic acid precursors include N-benzoyl pyrrolidone, dibenzoyl taurine and benzoyl pyroglutamic acid.

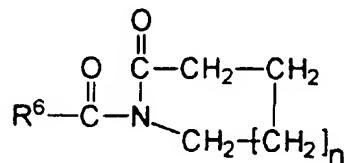
Other perbenzoic acid precursors include the benzoyl diacyl peroxides, the benzoyl tetraacyl peroxides, and the compound having the formula:



Phthalic anhydride is another suitable perbenzoic acid precursor compound herein:



Suitable N-acylated lactam perbenzoic acid precursors have the formula:



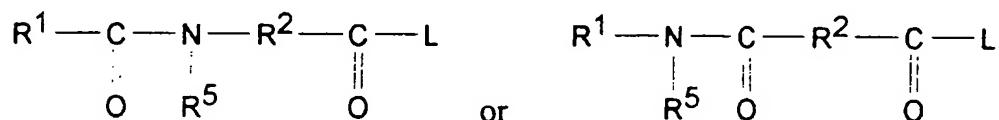
wherein n is from 0 to 8, preferably from 0 to 2, and R⁶ is a benzoyl group.

Perbenzoic acid derivative precursors

Perbenzoic acid derivative precursors provide substituted perbenzoic acids on perhydrolysis.

Suitable substituted perbenzoic acid derivative precursors include any of the herein disclosed perbenzoic precursors in which the benzoyl group is substituted by essentially any non-positively charged (ie; non-cationic) functional group including, for example alkyl, hydroxy, alkoxy, halogen, amine, nitrosyl and amide groups.

A preferred class of substituted perbenzoic acid precursor compounds are the amide substituted compounds of the following general formulae:



wherein R¹ is an aryl or alkaryl group with from 1 to 14 carbon atoms, R² is an arylene, or alkarylene group containing from 1 to 14 carbon atoms, and R⁵ is H or an alkyl, aryl, or alkaryl group containing 1 to 10 carbon atoms and L can be essentially any leaving group. R¹ preferably contains from 6 to 12 carbon atoms. R² preferably contains from 4 to 8 carbon atoms. R¹ may be aryl, substituted aryl or alkylaryl containing branching, substitution, or both and may be sourced from either synthetic sources or natural sources including for example, tallow fat. Analogous structural variations are permissible for R². The substitution can include alkyl, aryl, halogen, nitrogen, sulphur and other typical substituent groups or organic compounds. R⁵ is preferably H or methyl. R¹ and R⁵ should not contain more than 18 carbon atoms in total. Amide substituted bleach activator compounds of this type are described in EP-A-0170386.

Cationic peroxyacid precursors

Cationic peroxyacid precursor compounds produce cationic peroxyacids on perhydrolysis.

Typically, cationic peroxyacid precursors are formed by substituting the peroxyacid part of a suitable peroxyacid precursor compound with a positively charged functional group, such as an ammonium or alkyl ammonium group, preferably an ethyl or methyl ammonium group. Cationic peroxyacid precursors are typically present in the compositions as a salt with a suitable anion, such as for example a halide ion or a methylsulfate ion.

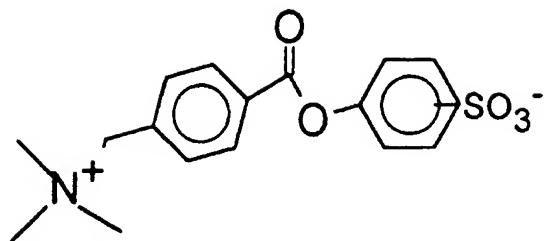
The peroxyacid precursor compound to be so cationically substituted may be a perbenzoic acid, or substituted derivative thereof, precursor compound as described hereinbefore. Alternatively, the peroxyacid precursor compound may be an alkyl percarboxylic acid precursor compound or an amide substituted alkyl peroxyacid precursor as described hereinafter

Cationic peroxyacid precursors are described in U.S. Patents 4,904,406; 4,751,015; 4,988,451; 4,397,757; 5,269,962; 5,127,852; 5,093,022; 5,106,528; U.K. 1,382,594; EP 475,512, 458,396 and 284,292; and in JP 87-318,332.

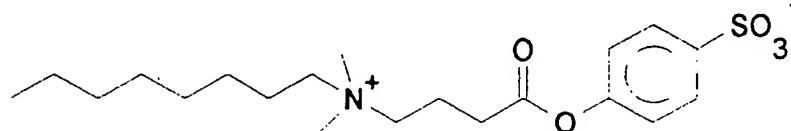
Examples of preferred cationic peroxyacid precursors are described in UK Patent Application No. 9407944.9 (attorney's docket no. CM642F) and US Patent Application Nos. 08/298903, 08/298650, 08/298904 and 08/298906 (attorney's docket no.s 5413 to 5416).

Suitable cationic peroxyacid precursors include any of the ammonium or alkyl ammonium substituted alkyl or benzoyl oxybenzene sulfonates, N-acylated caprolactams, and monobenzoyltetraacetyl glucose benzoyl peroxides.

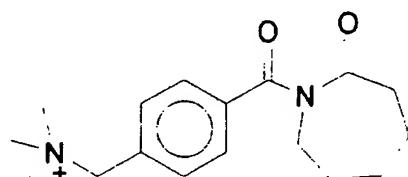
A preferred cationically substituted benzoyl oxybenzene sulfonate is the 4-(trimethyl ammonium) methyl derivative of benzoyl oxybenzene sulfonate:



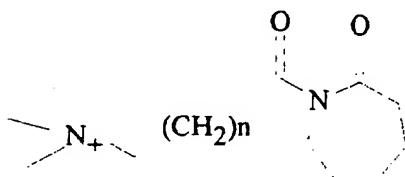
A preferred cationically substituted alkyl oxybenzene sulfonate has the formula:



Preferred cationic peroxyacid precursors of the N-acylated caprolactam class include the trialkyl ammonium methylene benzoyl caprolactams, particularly trimethyl ammonium methylene benzoyl caprolactam:



Other preferred cationic peroxyacid precursors of the N-acylated caprolactam class include the trialkyl ammonium methylene alkyl caprolactams:



where n is from 0 to 12, particularly from 1 to 5.

Another preferred cationic peroxyacid precursor is 2-(N,N,N-trimethyl ammonium) ethyl sodium 4-sulphophenyl carbonate chloride.

Alkyl percarboxylic acid bleach precursors

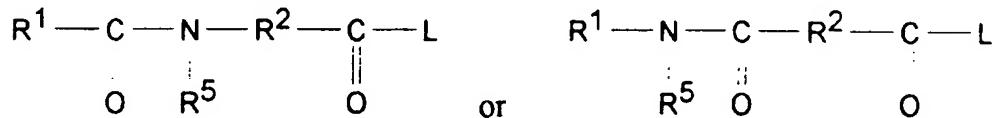
Alkyl percarboxylic acid bleach precursors form percarboxylic acids on perhydrolysis. Preferred precursors of this type provide peracetic acid on perhydrolysis.

Preferred alkyl percarboxylic precursor compounds of the imide type include the N,N,N¹N¹ tetra acetylated alkylene diamines wherein the alkylene group contains from 1 to 6 carbon atoms, particularly those compounds in which the alkylene group contains 1, 2 and 6 carbon atoms. Tetraacetyl ethylene diamine (TAED) is particularly preferred.

Other preferred alkyl percarboxylic acid precursors include sodium 3,5,5-trimethyl hexanoyloxybenzene sulfonate (iso-NOBS), sodium nonanoyloxybenzene sulfonate (NOBS), sodium acetoxybenzene sulfonate (ABS) and pentaacetyl glucose.

Amide substituted alkyl peroxyacid precursors

Amide substituted alkyl peroxyacid precursor compounds are also suitable, including those of the following general formulae:

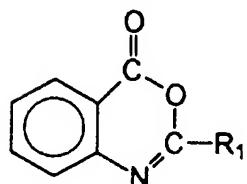


wherein R¹ is an alkyl group with from 1 to 14 carbon atoms, R² is an alkylene group containing from 1 to 14 carbon atoms, and R⁵ is H or an alkyl group containing 1 to 10 carbon atoms and L can be essentially any leaving group. R¹ preferably contains from 6 to 12 carbon atoms. R² preferably contains from 4 to 8 carbon atoms. R¹ may be straight chain or branched alkyl containing branching, substitution, or both and may be sourced from either synthetic sources or natural sources including for example, tallow fat. Analogous structural variations are permissible for R². The substitution can include alkyl, halogen, nitrogen, sulphur and other typical substituent groups or organic compounds. R⁵ is preferably H or

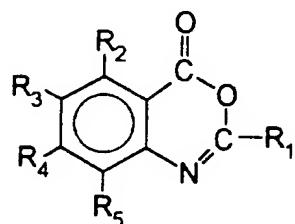
methyl. R¹ and R⁵ should not contain more than 18 carbon atoms in total. Amide substituted bleach activator compounds of this type are described in EP-A-0170386.

Benzoxazin organic peroxyacid precursors

Also suitable are precursor compounds of the benzoxazin-type, as disclosed for example in EP-A-332,294 and EP-A-482,807, particularly those having the formula:

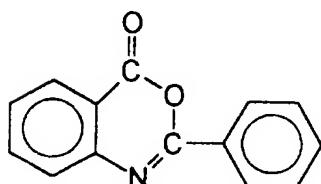


including the substituted benzoxazins of the type



wherein R₁ is H, alkyl, alkaryl, aryl, arylalkyl, and wherein R₂, R₃, R₄, and R₅ may be the same or different substituents selected from H, halogen, alkyl, alkenyl, aryl, hydroxyl, alkoxy, amino, alkyl amino, COOR₆ (wherein R₆ is H or an alkyl group) and carbonyl functions.

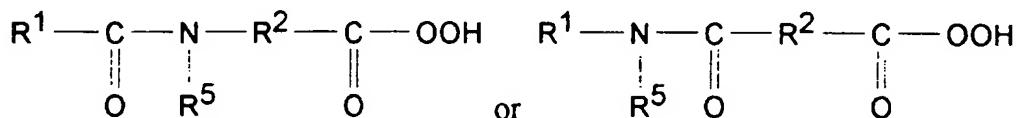
An especially preferred precursor of the benzoxazin-type is:



Preformed organic peroxyacid

The organic peroxyacid bleaching system may contain, in addition to, or as an alternative to, an organic peroxyacid bleach precursor compound, a preformed organic peroxyacid, typically at a level of from 0.5% to 25% by weight, more preferably from 1% to 10% by weight of the composition.

A preferred class of organic peroxyacid compounds are the amide substituted compounds of the following general formulae:



wherein R¹ is an alkyl, aryl or alkaryl group with from 1 to 14 carbon atoms, R² is an alkylene, arylene, and alkarylene group containing from 1 to 14 carbon atoms, and R⁵ is H or an alkyl, aryl, or alkaryl group containing 1 to 10 carbon atoms. R¹ preferably contains from 6 to 12 carbon atoms. R² preferably contains from 4 to 8 carbon atoms. R¹ may be straight chain or branched alkyl, substituted aryl or alkylaryl containing branching, substitution, or both and may be sourced from either synthetic sources or natural sources including for example, tallow fat. Analogous structural variations are permissible for R². The substitution can include alkyl, aryl, halogen, nitrogen, sulphur and other typical substituent groups or organic compounds. R⁵ is preferably H or methyl. R¹ and R⁵ should not contain more than 18 carbon atoms in total. Amide substituted organic peroxyacid compounds of this type are described in EP-A-0170386.

Other organic peroxyacids include diacyl and tetraacylperoxides, especially diperoxydodecanedioic acid, diperoxytetradecanedioic acid, and diperoxyhexadecanedioic acid. Dibenzoyl peroxide is a preferred organic peroxyacid herein. Mono- and diperazelaic acid, mono- and diperbrassylic acid, and N-phthaloylaminoperoxycaproic acid are also suitable herein.

Additional corrosion inhibitor compound

The compositions may contain additional corrosion inhibitors preferably selected from organic silver coating agents, particularly paraffin, nitrogen-containing corrosion inhibitor compounds and Mn(II) compounds, particularly Mn(II) salts of organic ligands.

Organic silver coating agents are described in PCT Publication No. WO94/16047 (attorney's docket no. CM497M) and copending UK Application No. UK 9413729.6 (attorney's docket no. CM750F). Nitrogen-containing corrosion inhibitor compounds are disclosed in copending European Application no. EP 93202095.1 (attorney's docket no. CM571F). Mn(II) compounds for use in corrosion inhibition are described in copending UK Application No. 9418567.5 (attorney's docket no. CM719FM).

Organic silver coating agents

Organic silver coating agent may be incorporated at a level of from 0.05% to 10%, preferably from 0.1% to 5% by weight of the total composition.

The functional role of the silver coating agent is to form 'in use' a protective coating layer on any silverware components of the washload to which the compositions of the invention are being applied. The silver coating agent should hence have a high affinity for attachment to solid silver surfaces, particularly when present in as a component of an aqueous washing and bleaching solution with which the solid silver surfaces are being treated.

Suitable organic silver coating agents herein include fatty esters of mono- or polyhydric alcohols having from 1 to about 40 carbon atoms in the hydrocarbon chain.

The fatty acid portion of the fatty ester can be obtained from mono- or polycarboxylic acids having from 1 to about 40 carbon atoms in the hydrocarbon chain. Suitable examples of monocarboxylic fatty acids include behenic acid, stearic acid, oleic acid, palmitic acid, myristic acid, lauric acid, acetic acid, propionic acid, butyric acid, isobutyric acid, valeric acid, lactic acid, glycolic acid and β,β' - dihydroxyisobutyric acid. Examples of suitable

polycarboxylic acids include: n-butyl-malonic acid, isocitric acid, citric acid, maleic acid, malic acid and succinic acid.

The fatty alcohol radical in the fatty ester can be represented by mono- or polyhydric alcohols having from 1 to 40 carbon atoms in the hydrocarbon chain. Examples of suitable fatty alcohols include; behenyl, arachidyl, cocoyl, oleyl and lauryl alcohol, ethylene glycol, glycerol, ethanol, isopropanol, vinyl alcohol, diglycerol, xylitol, sucrose, erythritol, pentaerythritol, sorbitol or sorbitan.

Preferably, the fatty acid and/or fatty alcohol group of the fatty ester adjunct material have from 1 to 24 carbon atoms in the alkyl chain.

Preferred fatty esters herein are ethylene glycol, glycerol and sorbitan esters wherein the fatty acid portion of the ester normally comprises a species selected from behenic acid, stearic acid, oleic acid, palmitic acid or myristic acid.

The glycerol esters are also highly preferred. These are the mono-, di- or tri-esters of glycerol and the fatty acids as defined above.

Specific examples of fatty alcohol esters for use herein include: stearyl acetate, palmityl di-lactate, cocoyl isobutyrate, oleyl maleate, oleyl dimaleate, and tallowyl propionate. Fatty acid esters useful herein include: xylitol monopalmitate, pentaerythritol monostearate, sucrose monostearate, glycerol monostearate, ethylene glycol monostearate, sorbitan esters. Suitable sorbitan esters include sorbitan monostearate, sorbitan palmitate, sorbitan monolaurate, sorbitan monomyristate, sorbitan monobehenate, sorbitan mono-oleate, sorbitan dilaurate, sorbitan distearate, sorbitan dibehenate, sorbitan dioleate, and also mixed tallowalkyl sorbitan mono- and di-esters.

Glycerol monostearate, glycerol mono-oleate, glycerol monopalmitate, glycerol monobehenate, and glycerol distearate are preferred glycerol esters herein.

Suitable organic silver coating agents include triglycerides, mono or diglycerides, and wholly or partially hydrogenated derivatives thereof, and any mixtures thereof. Suitable sources of fatty acid esters include vegetable and fish oils and animal fats. Suitable vegetable oils include soy bean oil, cotton seed oil, castor oil, olive oil, peanut oil, safflower oil, sunflower oil, rapeseed oil, grapeseed oil, palm oil and corn oil.

Waxes, including microcrystalline waxes are suitable organic silver coating agents herein. Preferred waxes have a melting point in the range from about 35°C to about 110°C and comprise generally from 12 to 70 carbon atoms. Preferred are petroleum waxes of the paraffin and microcrystalline type which are composed of long-chain saturated hydrocarbon compounds.

Alginates and gelatin are suitable organic silver coating agents herein.

Dialkyl amine oxides such as C₁₂-C₂₀ methylamine oxide, and dialkyl quaternary ammonium compounds and salts, such as the C₁₂-C₂₀ methylammonium halides are also suitable.

Other suitable organic silver coating agents include certain polymeric materials. Polyvinylpyrrolidones with an average molecular weight of from 12,000 to 700,000, polyethylene glycols (PEG) with an average molecular weight of from 600 to 10,000, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, and cellulose derivatives such as methylcellulose, carboxymethylcellulose and hydroxyethylcellulose are examples of such polymeric materials.

Certain perfume materials, particularly those demonstrating a high substantivity for metallic surfaces, are also useful as the organic silver coating agents herein.

Polymeric soil release agents known to those skilled in the art of formulating laundry detergent compositions can be used as the organic silver coating agent herein.

Suitable polymeric soil release agents include those soil release agents having: (a) one or more nonionic hydrophile components consisting

essentially of (i) polyoxyethylene segments with a degree of polymerization of at least 2, or (ii) oxypropylene or polyoxypropylene segments with a degree of polymerization of from 2 to 10, wherein said hydrophile segment does not encompass any oxypropylene unit unless it is bonded to adjacent moieties at each end by ether linkages, or (iii) a mixture of oxyalkylene units comprising oxyethylene and from 1 to about 30 oxypropylene units, said hydrophile segments preferably comprising at least about 25% oxyethylene units and more preferably, especially for such components having about 20 to 30 oxypropylene units, at least about 50% oxyethylene units; or (b) one or more hydrophobe components comprising (i) C₃ oxyalkylene terephthalate segments, wherein, if said hydrophobe components also comprise oxyethylene terephthalate, the ratio of oxyethylene terephthalate:C₃ oxyalkylene terephthalate units is about 2:1 or lower, (ii) C₄-C₆ alkylene or oxy C₄-C₆ alkylene segments, or mixtures therein, (iii) poly (vinyl ester) segments, preferably polyvinyl acetate, having a degree of polymerization of at least 2, or (iv) C₁-C₄ alkyl ether or C₄ hydroxyalkyl ether substituents, or mixtures therein, wherein said substituents are present in the form of C₁-C₄ alkyl ether or C₄ hydroxyalkyl ether cellulose derivatives, or mixtures therein, or a combination of (a) and (b).

Typically, the polyoxyethylene segments of (a)(i) will have a degree of polymerization of from about 200, although higher levels can be used, preferably from 3 to about 150, more preferably from 6 to about 100. Suitable oxy C₄-C₆ alkylene hydrophobe segments include, but are not limited to, end-caps of polymeric soil release agents such as MO₃S(CH₂)_nOCH₂CH₂O-, where M is sodium and n is an integer from 4-6, as disclosed in U.S. Patent 4,721,580, issued January 26, 1988 to Gosselink.

Polymeric soil release agents useful herein also include cellulosic derivatives such as hydroxyether cellulosic polymers, copolymeric blocks of ethylene terephthalate or propylene terephthalate with polyethylene oxide or polypropylene oxide terephthalate, and the like. Such agents are commercially available and include hydroxyethers of cellulose such as METHOCEL (Dow). Cellulosic soil release agents for use herein also include those selected from the group consisting of C₁-C₄ alkyl and C₄

hydroxyalkyl cellulose; see U.S. Patent 4,000,093, issued December 28, 1976 to Nicol, et al.

Soil release agents characterized by poly(vinyl ester) hydrophobe segments include graft copolymers of poly(vinyl ester), e.g., C₁-C₆ vinyl esters, preferably poly(vinyl acetate) grafted onto polyalkylene oxide backbones, such as polyethylene oxide backbones. See European Patent Application 0 219 048, published April 22, 1987 by Kud, et al.

Another suitable soil release agent is a copolymer having random blocks of ethylene terephthalate and polyethylene oxide (PEO) terephthalate. The molecular weight of this polymeric soil release agent is in the range of from about 25,000 to about 55,000. See U.S. Patent 3,959,230 to Hays, issued May 25, 1976 and U.S. Patent 3,893,929 to Basadur issued July 8, 1975.

Another suitable polymeric soil release agent is a polyester with repeat units of ethylene terephthalate units contains 10-15% by weight of ethylene terephthalate units together with 90-80% by weight of polyoxyethylene terephthalate units, derived from a polyoxyethylene glycol of average molecular weight 300-5,000.

Another suitable polymeric soil release agent is a sulfonated product of a substantially linear ester oligomer comprised of an oligomeric ester backbone of terephthaloyl and oxyalkyleneoxy repeat units and terminal moieties covalently attached to the backbone. These soil release agents are described fully in U.S. Patent 4,968,451, issued November 6, 1990 to J.J. Scheibel and E.P. Gosselink. Other suitable polymeric soil release agents include the terephthalate polyesters of U.S. Patent 4,711,730, issued December 8, 1987 to Gosselink et al, the anionic end-capped oligomeric esters of U.S. Patent 4,721,580, issued January 26, 1988 to Gosselink, and the block polyester oligomeric compounds of U.S. Patent 4,702,857, issued October 27, 1987 to Gosselink. Other polymeric soil release agents also include the soil release agents of U.S. Patent 4,877,896, issued October 31, 1989 to Maldonado et al, which discloses anionic, especially sulfoaroyl, end-capped terephthalate esters.

Another soil release agent is an oligomer with repeat units of terephthaloyl units, sulfoisoterephthaloyl units, oxyethyleneoxy and oxy-1,2-propylene units. The repeat units form the backbone of the oligomer and are preferably terminated with modified isethionate end-caps. A particularly preferred soil release agent of this type comprises about one sulfoisophthaloyl unit, 5 terephthaloyl units, oxyethyleneoxy and oxy-1,2-propyleneoxy units in a ratio of from about 1.7 to about 1.8, and two end-cap units of sodium 2-(2-hydroxyethoxy)-ethanesulfonate.

A preferred organic silver coating agent is a paraffin oil, typically a predominantly branched aliphatic hydrocarbon having a number of carbon atoms in the range of from 20 to 50; preferred paraffin oil selected from predominantly branched C₂₅₋₄₅ species with a ratio of cyclic to noncyclic hydrocarbons of from 1:10 to 2:1, preferably from 1:5 to 1:1. A paraffin oil meeting these characteristics, having a ratio of cyclic to noncyclic hydrocarbons of about 32:68, is sold by Wintershall, Salzbergen, Germany, under the trade name WINOG 70.

Nitrogen-containing corrosion inhibitor compounds

Suitable nitrogen-containing corrosion inhibitor compounds include imidazole and derivatives thereof such as benzimidazole, 2-heptadecyl imidazole and those imidazole derivatives described in Czech Patent No. 139, 279 and British Patent GB-A-1,137,741, which also discloses a method for making imidazole compounds.

Also suitable as nitrogen-containing corrosion inhibitor compounds are pyrazole compounds and their derivatives, particularly those where the pyrazole is substituted in any of the 1, 3, 4 or 5 positions by substituents R₁, R₃, R₄ and R₅ where R₁ is any of H, CH₂OH, CONH₃, or COCH₃, R₃ and R₅ are any of C₁-C₂₀ alkyl or hydroxyl, and R₄ is any of H, NH₂ or NO₂.

Other suitable nitrogen-containing corrosion inhibitor compounds include benzotriazole, 2-mercaptopbenzothiazole, 1-phenyl-5-mercaptop-1,2,3,4-tetrazole, thionalide, morpholine, melamine, distearylamine,

stearoyl stearamide, cyanuric acid, aminotriazole, aminotetrazole and indazole.

Nitrogen-containing compounds such as amines, especially distearylamine and ammonium compounds such as ammonium chloride, ammonium bromide, ammonium sulphate or diammonium hydrogen citrate are also suitable.

Mn(II) corrosion inhibitor compounds

The compositions may contain an Mn(II) corrosion inhibitor compound. The Mn(II) compound is preferably incorporated at a level of from 0.005% to 5% by weight, more preferably from 0.01% to 1%, most preferably from 0.02% to 0.4% by weight of the compositions. Preferably, the Mn(II) compound is incorporated at a level to provide from 0.1 ppm to 250 ppm, more preferably from 0.5 ppm to 50 ppm, most preferably from 1 ppm to 20 ppm by weight of Mn(II) ions in any bleaching solution.

The Mn (II) compound may be an inorganic salt in anhydrous, or any hydrated forms. Suitable salts include manganese sulphate, manganese carbonate, manganese phosphate, manganese nitrate, manganese acetate and manganese chloride. The Mn(II) compound may be a salt or complex of an organic fatty acid such as manganese acetate or manganese stearate.

The Mn(II) compound may be a salt or complex of an organic ligand. In one preferred aspect the organic ligand is a heavy metal ion sequestrant. In another preferred aspect the organic ligand is a crystal growth inhibitor.

Other corrosion inhibitor compounds

Other suitable additional corrosion inhibitor compounds include, mercaptans and diols, especially mercaptans with 4 to 20 carbon atoms including lauryl mercaptan, thiophenol, thionaphthol, thionalide and thioanthranol. Also suitable are saturated or unsaturated C₁₀-C₂₀ fatty acids, or their salts, especially aluminium tristearate. The C₁₂-C₂₀ hydroxy fatty acids, or their salts, are also suitable. Phosphonated octa-decane and other anti-oxidants such as betahydroxytoluene (BHT) are also suitable.

Copolymers of butadiene and maleic acid, particularly those supplied under the trade reference no. 07787 by Polysciences Inc have been found to be of particular utility as corrosion inhibitor compounds.

Total Available Oxygen (AvO) Level

It has been found that, for optimal anti-silver tarnishing performance, the level of available oxygen in the present compositions, measured in units of % available oxygen by weight of the composition, is preferably controlled; the level of available oxygen should hence preferably be in the range from 0.3% to 2.5%, preferably from 0.5% to 1.7%, more preferably from 0.6% to 1.5%, most preferably from 0.7% to 1.2%, measured according to the method described hereunder.

Rate of Release of AvO

The rate of release of available oxygen is preferably also controlled; the rate of release of available oxygen from the compositions herein preferably should be such that, when using the method described hereinafter, the available oxygen is not completely released from the composition until after 3.5 minutes, preferably the available oxygen is released in a time interval of from 3.5 minutes to 10.0 minutes, more preferably from 4.0 minutes to 9.0 minutes, most preferably from 5.0 minutes to 8.5 minutes.

Method for Measuring Level of Total Available Oxygen (AvO) and Rate of Release of AvO in a Detergent Composition

Method

1. A beaker of water (typically 2L) is placed on a stirrer Hotplate, and the stirrer speed is selected to ensure that the product is evenly dispersed through the solution.

2. The detergent composition (typically 8g of product which has been sampled down from a bulk supply using a Pascal sampler), is added and simultaneously a stop clock is started.
3. The temperature control should be adjusted so as to maintain a constant temperature of 20°C throughout the experiment.
4. Samples are taken from the detergent solution at 2 minute time intervals for 20 minutes, starting after 1 minute, and are titrated by the "titration procedure" described below to determine the level of available oxygen at each point.

Titration Procedure

1. An aliquot from the detergent solution (above) and 2ml sulphuric acid are added into a stirred beaker
2. Approximately 0.2g ammonium molybdate catalyst (tetra hydrate form) are added
3. 3mls of 10% sodium iodide solution are added
4. Titration with sodium thiosulphate is conducted until the end point. The end point can be seen using either of two procedures. First procedure consists simply in seeing the yellow iodine colour fading to clear. The second and preferred procedure consists of adding soluble starch when the yellow colour is becoming faint, turning the solution blue. More thiosulphate is added until the end point is reached (blue starch complex is decolourised).

The level of AvO, measured in units of % available oxygen by weight, for the sample at each time interval corresponds to the amount of titre according to the following equation

$$\frac{\text{Vol S}_2\text{O}_3(\text{ml}) \times \text{Molarity (S}_2\text{O}_3) \times 8}{\text{Sample mass (g)}}$$

AvO level is plotted versus time to determine the maximum level of AvO, and the rate of release of AvO

Controlled rate of release - means

A means may be provided for controlling the rate of release of oxygen bleach to the wash solution.

Means for controlling the rate of release of the bleach may provide for controlled release of peroxide species to the wash solution. Such means could, for example, include controlling the release of any inorganic perhydrate salt, acting as a hydrogen peroxide source, to the wash solution.

Suitable controlled release means can include coating any suitable component with a coating designed to provide the controlled release. The coating may therefore, for example, comprise a poorly water soluble material, or be a coating of sufficient thickness that the kinetics of dissolution of the thick coating provide the controlled rate of release.

The coating material may be applied using various methods. Any coating material is typically present at a weight ratio of coating material to bleach of from 1:99 to 1:2, preferably from 1:49 to 1:9.

Suitable coating materials include triglycerides (e.g. partially) hydrogenated vegetable oil, soy bean oil, cotton seed oil) mono or diglycerides, microcrystalline waxes, gelatin, cellulose, fatty acids and any mixtures thereof.

Other suitable coating materials can comprise the alkali and alkaline earth metal sulphates, silicates and carbonates, including calcium carbonate and silicas.

A preferred coating material, particularly for an inorganic perhydrate salt bleach source, comprises sodium silicate of $\text{SiO}_2 : \text{Na}_2\text{O}$ ratio from 1.8 : 1 to 3.0 : 1, preferably 1.8:1 to 2.4:1, and/or sodium metasilicate, preferably applied at a level of from 2% to 10%, (normally from 3% to 5%) of SiO_2 by weight of the inorganic perhydrate salt. Magnesium silicate can also be included in the coating.

Other means of providing the required controlled release include mechanical means for altering the physical characteristics of the bleach to control its solubility and rate of release. Suitable protocols could include compaction, mechanical injection, manual injection, and adjustment of the solubility of the bleach compound by selection of particle size of any particulate component.

Whilst the choice of particle size will depend both on the composition of the particulate component, and the desire to meet the desired controlled release kinetics, it is desirable that the particle size should be more than 500 micrometers, preferably having an average particle diameter of from 800 to 1200 micrometers.

Additional protocols for providing the means of controlled release include the suitable choice of any other components of the detergent composition matrix such that when the composition is introduced to the wash solution the ionic strength environment therein provided enables the required controlled release kinetics to be achieved.

Detergent compositions

According to another aspect of the invention detergent compositions containing the bleaching compositions hereinbefore described and one or more detergent ingredients are provided. The detergent ingredients are preferably selected from builder compounds, sources of alkalinity, surfactants, heavy metal ion sequestrants, crystal growth inhibitors, enzymes, organic polymeric compounds, and suds suppressors.

The binding constant for bismuth with organic diphosphonate ligands has, in general, been found to be high enough to ensure the stability of the salt or complex in a bleaching/detergent product, but weak enough such that on introduction of the product to a wash solution the bismuth ions are readily released from the compound to the wash solution.

The detergent compositions preferably contain the bismuth diphosphonate compound at a level of from 0.005% to 20%, more preferably from 0.01% to 5%, most preferably from 0.1% to 1% by weight of the detergent composition.

Preferred detergent compositions herein are adapted for use in a machine dishwashing method. Such compositions are formulated to enable the removal of, typically food based, soils and stains from soiled tableware under the conditions present in a machine dishwasher. Typically the compositions are low foaming, preferably containing only low levels of low-foaming surfactants.

A preferred detergent composition herein comprises a detergent component selected from the group consisting of a water soluble builder compound, a low foaming surfactant system and any mixtures thereof, and the hereinbefore described bleaching composition.

Water-soluble builder compound

The detergent compositions of the present invention may contain as a highly preferred component a water-soluble builder compound, typically present at a level of from 1% to 80% by weight, preferably from 10% to 70% by weight, most preferably from 20% to 60% by weight of the composition.

Suitable water-soluble builder compounds include the water soluble monomeric polycarboxylates, or their acid forms, homo or copolymeric polycarboxylic acids or their salts in which the polycarboxylic acid comprises at least two carboxylic radicals separated from each other by not more than two carbon atoms, carbonates, bicarbonates, borates, phosphates, and mixtures of any of the foregoing.

The carboxylate or polycarboxylate builder can be monomeric or oligomeric in type although monomeric polycarboxylates are generally preferred for reasons of cost and performance.

Suitable carboxylates containing one carboxy group include the water soluble salts of lactic acid, glycolic acid and ether derivatives thereof. Polycarboxylates containing two carboxy groups include the water-soluble salts of succinic acid, malonic acid, (ethylenedioxy) diacetic acid, maleic acid, diglycolic acid, tartaric acid, tartronic acid and fumaric acid, as well as the ether carboxylates and the sulfinyl carboxylates. Polycarboxylates containing three carboxy groups include, in particular, water-soluble citrates, aconitrates and citraconates as well as succinate derivatives such as the carboxymethyloxysuccinates described in British Patent No. 1,379,241, lactoxysuccinates described in British Patent No. 1,389,732, and aminosuccinates described in Netherlands Application 7205873, and the oxypolycarboxylate materials such as 2-oxa-1,1,3-propane tricarboxylates described in British Patent No. 1,387,447.

Polycarboxylates containing four carboxy groups include oxydisuccinates disclosed in British Patent No. 1,261,829, 1,1,2,2-ethane tetracarboxylates, 1,1,3,3-propane tetracarboxylates and 1,1,2,3-propane tetracarboxylates. Polycarboxylates containing sulfo substituents include the sulfosuccinate derivatives disclosed in British Patent Nos. 1,398,421 and 1,398,422 and in U.S. Patent No. 3,936,448, and the sulfonated pyrolysed citrates described in British Patent No. 1,439,000.

Alicyclic and heterocyclic polycarboxylates include cyclopentane-cis,cis,cis-tetracarboxylates, cyclopentadienide pentacarboxylates, 2,3,4,5-tetrahydrofuran - cis, cis, cis-tetracarboxylates, 2,5-tetrahydrofuran - cis - dicarboxylates, 2,2,5,5-tetrahydrofuran - tetracarboxylates, 1,2,3,4,5,6-hexane - hexacarboxylates and carboxymethyl derivatives of polyhydric alcohols such as sorbitol, mannitol and xylitol. Aromatic polycarboxylates include mellitic acid, pyromellitic acid and the phthalic acid derivatives disclosed in British Patent No. 1,425,343.

Of the above, the preferred polycarboxylates are hydroxycarboxylates containing up to three carboxy groups per molecule, more particularly citrates.

The parent acids of the monomeric or oligomeric polycarboxylate chelating agents or mixtures thereof with their salts, e.g. citric acid or citrate/citric acid mixtures are also contemplated as useful builder components.

Borate builders, as well as builders containing borate-forming materials that can produce borate under detergent storage or wash conditions can also be used but are not preferred at wash conditions less than about 50°C, especially less than about 40°C.

Examples of carbonate builders are the alkaline earth and alkali metal carbonates, including sodium carbonate and sesqui-carbonate and mixtures thereof with ultra-fine calcium carbonate as disclosed in German Patent Application No. 2,321,001 published on November 15, 1973.

Specific examples of water-soluble phosphate builders are the alkali metal tripolyphosphates, sodium, potassium and ammonium pyrophosphate, sodium and potassium and ammonium pyrophosphate, sodium and potassium orthophosphate, sodium polymeta/phosphate in which the degree of polymerization ranges from about 6 to 21, and salts of phytic acid.

Partially soluble or insoluble builder compound

The detergent compositions of the present invention may less preferably contain a partially soluble or insoluble builder compound. Examples of partially water soluble builders include the crystalline layered silicates as disclosed for example, in EP-A-0164514, DE-A-3417649 and DE-A-3742043. Examples of largely water insoluble builders include the sodium aluminosilicates, including Zeolite A, Zeolite B, Zeolite P, Zeolite X, Zeolite MAP, Zeolite HS and mixtures thereof.

Alkalinity system

The detergent compositions preferably contain an alkalinity system containing sodium silicate having an $\text{SiO}_2 : \text{Na}_2\text{O}$ ratio of from 1.8 to 3.0, preferably from 1.8 to 2.4, most preferably 2.0, present preferably at a level of less than 20%, preferably from 1% to 15%, most preferably from 3% to 12% by weight of SiO_2 . The alkali metal silicate may be in the form of either the anhydrous salt or a hydrated salt.

The alkalinity system also preferably contains sodium metasilicate, present at a level of at least 0.4% SiO_2 by weight. Sodium metasilicate has a nominal $\text{SiO}_2 : \text{Na}_2\text{O}$ ratio of 1.0. The weight ratio of said sodium silicate to said sodium metasilicate, measured as SiO_2 , is preferably from 50:1 to 5:4, more preferably from 15:1 to 2:1, most preferably from 10:1 to 5:2.

Surfactant

A highly preferred component of the detergent compositions of the invention is a surfactant system comprising surfactant selected from anionic, cationic, nonionic ampholytic and zwitterionic surfactants and mixtures thereof. Automatic dishwashing machine products should be low foaming in character and thus the foaming of the surfactant system must be suppressed or more preferably be low foaming, typically nonionic in character. The surfactant system is typically present at a level of from 0.2% to 30% by weight, more preferably from 0.5% to 10% by weight, most preferably from 1% to 5% by weight of the compositions.

A typical listing of anionic, nonionic, ampholytic and zwitterionic classes, and species of these surfactants, is given in U.S.P. 3,929,678 issued to Laughlin and Heuring on December, 30, 1975. A list of suitable cationic surfactants is given in U.S.P. 4,259,217 issued to Murphy on March 31, 1981. A listing of surfactants typically included in automatic dishwashing detergent compositions is given for example, in EP-A-0414 549 and PCT Applications No.s WO 93/08876 (attorney's docket no. CM465M) and WO 93/08874 (attorney's docket no. CM595M)..

Nonionic surfactant

Essentially any nonionic surfactants useful for detergents purposes can be included in the compositions. Preferred, non-limiting classes of useful nonionic surfactants are listed below.

Nonionic ethoxylated alcohol surfactant

The alkyl ethoxylate condensation products of aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide are suitable for use herein. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from 6 to 22 carbon atoms. Particularly preferred are the condensation products of alcohols having an alkyl group containing from 8 to 20 carbon atoms with from about 2 to about 10 moles of ethylene oxide per mole of alcohol.

Nonionic ethoxylated/propoxylated fatty alcohol surfactant

The ethoxylated C₆-C₁₈ fatty alcohols and C₆-C₁₈ mixed ethoxylated/propoxylated fatty alcohols are suitable surfactants for use herein, particularly where water soluble. Preferably the ethoxylated fatty alcohols are the C₁₀-C₁₈ ethoxylated fatty alcohols with a degree of ethoxylation of from 3 to 50, most preferably these are the C₁₂-C₁₈ ethoxylated fatty alcohols with a degree of ethoxylation from 3 to 40. Preferably the mixed ethoxylated/propoxylated fatty alcohols have an alkyl chain length of from 10 to 18 carbon atoms, a degree of ethoxylation of from 3 to 30 and a degree of propoxylation of from 1 to 10.

Nonionic EO/PO condensates with propylene glycol

The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol are suitable for use herein. The hydrophobic portion of these compounds preferably has a molecular weight of from about 1500 to about 1800 and exhibits water insolubility. Examples of compounds of this type include certain of the commercially-available PluronicTM surfactants, marketed by BASF.

Nonionic EO condensation products with propylene oxide/ethylene diamine adducts

The condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine are suitable for use herein. The hydrophobic moiety of these products consists of the reaction product of ethylenediamine and excess propylene oxide, and generally has a molecular weight of from about 2500 to about 3000. Examples of this type of nonionic surfactant include certain of the commercially available Tetronic™ compounds, marketed by BASF.

Heavy metal ion sequestrant

The detergent compositions of the invention preferably contain as an optional component a heavy metal ion sequestrant. By heavy metal ion sequestrant it is meant herein components which act to sequester (chelate) heavy metal ions. These components may also have calcium and magnesium chelation capacity, but preferentially they show selectivity to binding heavy metal ions such as iron, manganese and copper.

Heavy metal ion sequestrants are generally present at a level of from 0.005% to 20%, preferably from 0.1% to 10%, more preferably from 0.25% to 7.5% and most preferably from 0.5% to 5% by weight of the compositions.

Heavy metal ion sequestrants, which are acidic in nature, having for example phosphonic acid or carboxylic acid functionalities, may be present either in their acid form or as a complex/salt with a suitable counter cation such as an alkali or alkaline metal ion, ammonium, or substituted ammonium ion, or any mixtures thereof. Preferably any salts/complexes are water soluble. The molar ratio of said counter cation to the heavy metal ion sequestrant is preferably at least 1:1.

Suitable heavy metal ion sequestrants for use herein include organic phosphonates, such as the amino alkylene poly (alkylene phosphonates), alkali metal ethane 1-hydroxy disphosphonates and nitrilo trimethylene phosphonates. Preferred among the above species are diethylene triamine

penta (methylene phosphonate), ethylene diamine tri (methylene phosphonate) hexamethylene diamine tetra (methylene phosphonate) and hydroxy-ethylene 1,1 diphosphonate.

Other suitable heavy metal ion sequestrant for use herein include nitrilotriacetic acid and polyaminocarboxylic acids such as ethylenediaminetetracetic acid, ethylenetriamine pentacetic acid, ethylenediamine disuccinic acid, ethylenediamine diglutaric acid, 2-hydroxypropylenediamine disuccinic acid or any salts thereof.

Especially preferred is ethylenediamine-N,N'-disuccinic acid (EDDS) or the alkali metal, alkaline earth metal, ammonium, or substituted ammonium salts thereof, or mixtures thereof. Preferred EDDS compounds are the free acid form and the sodium or magnesium salt or complex thereof.

Crystal growth inhibitor component

The detergent compositions, in addition to the bismuth diphosphonate compound, preferably contain a crystal growth inhibitor component, preferably an additional organodiphosphonate component, incorporated preferably at a level of from 0.01% to 5%, more preferably from 0.1% to 2% by weight of the compositions.

By organo diphosphonate it is meant herein an organo diphosphonate salt or organo diphosphonic acid which does not contain nitrogen as part of its chemical structure. This definition therefore excludes the organo aminophosphonates, which however may be included in compositions of the invention as heavy metal ion sequestrant components.

The organo diphosphonate is preferably a C₁-C₄ diphosphonate, more preferably a C₂ diphosphonate, such as ethylene diphosphonate, or most preferably ethane 1-hydroxy-1,1-diphosphonate (HEDP) and may be present in partially or fully ionized form, particularly as a salt or complex.

Enzyme

Another optional ingredient useful in the detergent compositions is one or more enzymes. Preferred enzymatic materials include the commercially available lipases, amylases, neutral and alkaline proteases, esterases, cellulases, pectinases, lactases and peroxidases conventionally incorporated into detergent compositions. Suitable enzymes are discussed in US Patents 3,519,570 and 3,533,139.

Preferred commercially available protease enzymes include those sold under the tradenames Alcalase, Savinase, Primase, Durazym, and Esperase by Novo Industries A/S (Denmark), those sold under the tradename Maxatase, Maxacal and Maxapem by Gist-Brocades, those sold by Genencor International, and those sold under the tradename Opticlean and Optimase by Solvay Enzymes. Protease enzyme may be incorporated into the compositions in accordance with the invention at a level of from 0.0001% to 4% active enzyme by weight of the composition.

Preferred amylases include, for example, α -amylases obtained from a special strain of *B licheniformis*, described in more detail in GB-1,269,839 (Novo). Preferred commercially available amylases include for example, those sold under the tradename Rapidase by Gist-Brocades, and those sold under the tradename Termamyl and BAN by Novo Industries A/S. Amylase enzyme may be incorporated into the composition in accordance with the invention at a level of from 0.0001% to 2% active enzyme by weight of the composition.

Lipolytic enzyme (lipase) may be present at levels of active lipolytic enzyme of from 0.0001% to 2% by weight, preferably 0.001% to 1% by weight, most preferably from 0.001% to 0.5% by weight of the compositions. The lipase may be fungal or bacterial in origin. Lipase from chemically or genetically modified mutants of these strains are also useful herein. A preferred lipase is described in Granted European Patent, EP-B-0218272.

An especially preferred lipase herein is obtained by cloning the gene from Humicola lanuginosa and expressing the gene in Aspergillus oryza, as host, as described in European Patent Application, EP-A-0258 068, which is

commercially available from Novo Industri A/S, Bagsvaerd, Denmark, under the trade name Lipolase. This lipase is also described in U.S. Patent 4,810,414, Huge-Jensen et al, issued March 7, 1989.

Enzyme Stabilizing System

Preferred enzyme-containing compositions herein may comprise from about 0.001% to about 10%, preferably from about 0.005% to about 8%, most preferably from about 0.01% to about 6%, by weight of an enzyme stabilizing system. The enzyme stabilizing system can be any stabilizing system which is compatible with the detergents enzyme. Such stabilizing systems can comprise calcium ion, boric acid, propylene glycol, short chain carboxylic acid, boronic acid, chlorine bleach scavengers and mixtures thereof. Such stabilizing systems can also comprise reversible enzyme inhibitors, such as reversible protease inhibitors.

Organic polymeric compound

Organic polymeric compounds may be added as preferred components of the detergent compositions in accord with the invention. By organic polymeric compound it is meant essentially any polymeric organic compound commonly used as dispersants, and anti-redeposition and soil suspension agents in detergent compositions.

Organic polymeric compound is typically incorporated in the detergent compositions of the invention at a level of from 0.1% to 30%, preferably from 0.5% to 15%, most preferably from 1% to 10% by weight of the compositions.

Examples of organic polymeric compounds include the water soluble organic homo- or co-polymeric polycarboxylic acids or their salts in which the polycarboxylic acid comprises at least two carboxyl radicals separated from each other by not more than two carbon atoms. Polymers of the latter type are disclosed in GB-A-1,596,756. Examples of such salts are polyacrylates of molecular weight 2000-10000 and their copolymers with any suitable other monomer units including modified acrylic, fumaric, maleic, itaconic, aconitic, mesaconic, citraconic and methylenemalonic acid

or their salts, maleic anhydride, acrylamide, alkylene, vinylmethyl ether, styrene and any mixtures thereof. Preferred are the copolymers of acrylic acid and maleic anhydride having a molecular weight of from 20,000 to 100,000.

Preferred commercially available acrylic acid containing polymers having a molecular weight below 15,000 include those sold under the tradename Sokalan PA30, PA20, PA15, PA10 and Sokalan CP10 by BASF GmbH, and those sold under the tradename Acusol 45N by Rohm and Haas.

Preferred acrylic acid containing copolymers include those which contain as monomer units: a) from 90% to 10%, preferably from 80% to 20% by weight acrylic acid or its salts and b) from 10% to 90%, preferably from 20% to 80% by weight of a substituted acrylic monomer or its salts having the general formula $-\text{[CR}_2\text{-CR}_1(\text{CO-O-R}_3)]-$ wherein at least one of the substituents R₁, R₂ or R₃, preferably R₁ or R₂ is a 1 to 4 carbon alkyl or hydroxyalkyl group, R₁ or R₂ can be a hydrogen and R₃ can be a hydrogen or alkali metal salt. Most preferred is a substituted acrylic monomer wherein R₁ is methyl, R₂ is hydrogen (i.e. a methacrylic acid monomer). The most preferred copolymer of this type has a molecular weight of 3500 and contains 60% to 80% by weight of acrylic acid and 40% to 20% by weight of methacrylic acid.

The polyamino compounds are useful herein including those derived from aspartic acid such as those disclosed in EP-A-305282, EP-A-305283 and EP-A-351629.

Lime soap dispersant compound

The detergent compositions of the invention may contain a lime soap dispersant compound, preferably present at a level of from 0.1% to 40% by weight, more preferably 1% to 20% by weight, most preferably from 2% to 10% by weight of the compositions.

A lime soap dispersant is a material that prevents the precipitation of alkali metal, ammonium or amine salts of fatty acids by calcium or magnesium

ions. Preferred lime soap disperant compounds are disclosed in PCT Application No. WO93/08877 (attorney's docket no. CM466M).

Suds suppressing system

The detergent compositions of the invention, when formulated for use in machine washing compositions, preferably comprise a suds suppressing system present at a level of from 0.01% to 15%, preferably from 0.05% to 10%, most preferably from 0.1% to 5% by weight of the composition.

Suitable suds suppressing systems for use herein may comprise essentially any known antifoam compound, including, for example silicone antifoam compounds, 2-alkyl and alanol antifoam compounds. Preferred suds suppressing systems and antifoam compounds are disclosed in PCT Application No. WO93/08876 (attorney's docket no. CM465M) and copending European Application No. 93870132.3 (attorney's docket no. CM562F).

Polymeric dye transfer inhibiting agents

The detergent compositions herein may also comprise from 0.01% to 10 %, preferably from 0.05% to 0.5% by weight of polymeric dye transfer inhibiting agents.

The polymeric dye transfer inhibiting agents are preferably selected from polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, polyvinylpyrrolidonepolymers or combinations thereof.

pH of the compositions

The present detergent compositions are preferably not formulated to have an unduly high pH, in preference having a pH measured as a 1% solution in distilled water of from 8.0 to 12.0, more preferably from 9.0 to 11.8, most preferably from 9.5 to 11.5.

Form of the compositions

The detergent compositions of the invention can be formulated in any desirable form such as powders, granulates, pastes, liquids, gels and tablets, solid, particularly granular forms being preferred.

The bulk density of the granular detergent compositions in accordance with the present invention is typically of at least 650 g/litre, more usually at least 700 g/litre and more preferably from 800 g/litre to 1200 g/litre.

The particle size of the components of granular compositions in accordance with the invention should preferably be such that no more than 5% of particles are greater than 1.4mm in diameter and not more than 5% of particles are less than 0.15mm in diameter.

Generally, if the compositions are in liquid form the liquid should be thixotropic (ie; exhibit high viscosity when subjected to low stress and lower viscosity when subjected to high stress), or at least have very high viscosity, for example, of from 1,000 to 10,000,000 centipoise.

Machine dishwashing method

Any suitable methods for machine washing or cleaning soiled tableware, particularly soiled silverware are envisaged.

A preferred machine dishwashing method comprises treating soiled articles selected from crockery, glassware, hollowware, silverware and cutlery and mixtures thereof, with an aqueous liquid having dissolved or dispersed therein an effective amount of a machine dishwashing composition in accord with the invention. By an effective amount of the machine dishwashing composition it is meant from 8g to 60g of product dissolved or dispersed in a wash solution of volume from 3 to 10 litres, as are typical product dosages and wash solution volumes commonly employed in conventional machine dishwashing methods.

In the Examples, the abbreviated component identifications have the following meanings:

Nonionic	: C ₁₃ -C ₁₅ mixed ethoxylated/propoxylated fatty alcohol with an average degree of ethoxylation of 3.8 and an average degree of propoxylation of 4.5 sold under the tradename Plurafac LF404 by BASF GmbH (low foaming)
Metasilicate	: Sodium metasilicate (SiO ₂ :Na ₂ O ratio = 1.0)
Silicate	: Amorphous Sodium Silicate (SiO ₂ :Na ₂ O ratio = 2.0)
Carbonate	: Anhydrous sodium carbonate
Phosphate	: Sodium tripolyphosphate
480N	: Random copolymer of 3:7 acrylic/methacrylic acid, average molecular weight about 3,500
Citrate	: Tri-sodium citrate dihydrate
PB1	: Anhydrous sodium perborate monohydrate
TAED	: Tetraacetyl ethylene diamine
Cationic precursor	: Cationic peroxyacid bleach precursor salt of trialkyl ammonium methylene C ₅ -alkyl caprolactam with tosylate
BzP	: Dibenzoyl peroxide
DETPMP	: Diethylene triamine penta (methylene phosphonic acid), marketed by Monsanto under the tradename Dequest 2060

HEDP	: Ethane 1-hydroxy-1,1-diphosphonic acid
Paraffin	: Paraffin oil sold under the tradename Winog 70 by Wintershall.
BD/MA	: Copolymer of butadiene/maleic acid as sold by Polysciences inc under the tradename reference no. 07787
Protease	: Proteolytic enzyme sold under the tradename Savinase by Novo Industries A/S (approx 2% enzyme activity).
Amylase	: Amylolytic enzyme sold under the tradename Termamyl 60T by Novo Industries A/S (approx 0.9% enzyme activity)
BSA	: Amylolytic enzyme sold under the tradename LE17 by Novo Industries A/S (approx 1% enzyme activity)
Sulphate	: Anhydrous sodium sulphate.
pH	: Measured as a 1% solution in distilled water at 20°C.

In the following examples all levels of enzyme quoted are expressed as % active enzyme by weight of the composition.

Example 1

Agglomerate particles containing bismuth diphosphonate compounds were prepared as follows:

(a) Making of bismuth HEDP solutions

Three different bismuth HEDP solutions were made up according to the following procedure. The exact volumes of HEDP solution and bismuth nitrate solution employed were adjusted such as to give final bismuth HEDP solutions with molar ratios of bismuth to HEDP of approximately 1:2.1, 1:3.5 and 1:5.0 respectively.

(i) 1:5.0 ratio

560g of 32% NaOH solution was taken. To this was continuously added with stirring 334g of a 60% solution of HEDP over a time period of 20 minutes. The temperature was not allowed to exceed 80°C. To the resulting solution was added with stirring 122g of a 23% solution of bismuth nitrate over a period of 2 minutes.

(ii) 1:3.5 ratio

480g of 29% NaOH solution was taken. To this was continuously added with stirring 238g of a 60% solution of HEDP over a time period of 20 minutes. The temperature was not allowed to exceed 80°C. To the resulting solution was added with stirring 122g of a 23% solution of bismuth nitrate over a period of 2 minutes.

(iii) 1:2.1 ratio

400g of 25% NaOH solution was taken. To this was continuously added with stirring 144g of a 60% solution of HEDP over a time period of 20 minutes. The temperature was not allowed to exceed 80°C. To the resulting solution was added with stirring 122g of a 23% solution of bismuth nitrate over a period of 2 minutes.

For each of (i) to (iii) above, on addition of the bismuth nitrate a white precipitate formed, but this dissolved rapidly on further stirring of the resultant mixture.

(b) Making of bismuth HEDP particles

Bismuth HEDP particles were made by co-agglomeration of a solution formed by mixing the 1:2.1, 1:3.5 and 1:5.0 alkaline bismuth HEDP solutions with an alkaline solution (pH 12.0) of 480N binder, (formed by adding 333g of 480N binder with 10g of 50% NaOH) with sodium sulfate powder.

The exact amounts of alkaline bismuth HEDP added to the alkaline 480N binder solution were:

1:5.0 ratio 127g of 1:5.0 bismuth HEDP solution

1:3.5 ratio 105g of 1:3.5 bismuth HEDP solution

1:2.1 ratio 83g of 1:2.1 bismuth HEDP solution

The agglomeration was carried out 20 minutes after preparation of the alkaline bismuth HEDP/binder solution as follows:

500g of anhydrous sodium sulfate powder was placed in a Kenwood Chef (tradename) mixing bowl. The K-beater (tradename) attachment was secured to the mixer and the sulfate mixed. During this mixing the alkaline bismuth HEDP/binder solution was trickled slowly onto the sulfate until this became slightly moist. The mixing was then stopped and the contents of the mixing bowl transferred to a fluid bed drier glass vessel. The sulphate was therein dried whilst fluidising at 80-90°C. After 5 minutes drying the sulfate was transferred back to the mixing bowl and more solution added slowly until the sulfate was again moist. These liquid addition/drying steps were repeated 15-20 times until all of the solution had been used up. The resultant particles

were then finally dried and sieved through a 1700 μm mesh to reduce oversize.

The resulting agglomerates had the following compositions (% parts by weight), where $n = 2.1, 3.5$ or 5.0 :

	Bismuth (1:n) HEDP	480N	Sodium sulfate
Bismuth (1:2.1) HEDP particle	2.0	22.8	75.2
Bismuth (1:3.5) HEDP particle	3.0	22.8	74.2
Bismuth (1:5.0) HEDP particle	4.0	22.8	73.2

Example 2

The following bleach-containing machine dishwashing compositions were prepared (parts by weight). Compositions A is a comparative composition, compositions B to H are in accord with the invention. The Bismuth HEDP particles were made in accord with the process set out in Example 1.

Comparative testing - silver tarnishing

The silver tarnish prevention performance of Compositions B to D, in accord with the invention was compared to that of comparative Composition A using the following twenty cycle test procedure. A set of three silver spoons were placed in the cutlery basket of each of four Bosch (tradename) machine dishwashers. Twenty grams of background soil, comprising 1 part by weight of each of Prince's (tradename) tinned stewing steak, Heinz (tradename) tinned baked beans and Ambrosia (tradename) tinned creamed rice, well mixed together, was added to each dishwasher by placing the soil in a 50 cm³ plastic beaker which was stood inverted in the upper rack of the dishwasher. A spike comprising 10 cm³ of 0.262% by weight CaCl₂. 6H₂O solution was added by pipette to the bottom of each dishwasher. The 65°C wash setting was selected, the wash process comprising main wash and rinse cycles. 20 grams of each composition was employed for each complete wash process. The feed water hardness was 8° Clark Hardness (114.3 ppm CaCO₃ equivalent). Each set of three spoons was washed five times in each of the four machines (ie: 20 complete wash + rinse cycles).

At the end of the final wash process the spoons were removed and then graded for silver tarnishing. The grading was performed by 4 expert graders and the results averaged for each of the four sets of three spoons. Grading was through visual inspection according to the following scale :

- 0 = no tarnish (shiny silver)
- 1 = very slight tarnish
- 2 = tarnish
- 3 = very tarnished
- 4 = severe tarnish (black coverage)

Results were as follows : (average of the 4 gradings from the panellists)

Composition	A	B	C	D
Tarnish grade	2.0	1.0	0.5	1.0

Comparison of the grade obtained for Composition A with that obtained for Compositions B to D shows that less silver tarnishing is obtained for the compositions in accord with the invention.

Storage stability

A 1kg sample of Composition C, as defined above, was stored in a plastic bottle for two weeks at 40°C and ambient humidity. The performance testing protocol as described above was then repeated with the Composition after storage. A tarnish grade of 0.5 was obtained, indicating that the bismuth/HEDP compound does not lose performance capability upon storage under these conditions.

CLAIMS

1. A bismuth diphosphonate compound wherein the molar ratio of bismuth to diphosphonate components is from 1:0.7 to 1:7.
2. A bismuth diphosphonate compound according to Claim 1 wherein said molar ratio is from 1:3 to 1:7.
3. A bismuth diphosphonate compound according to either of Claims 1 or 2 wherein said diphosphonate component is ethane 1-hydroxy-1,1-diphosphonate.
4. A process for making an alkaline solution containing a bismuth diphosphonate according to any of Claims 1 to 3 comprising the following steps:
 - (i) formation of an alkaline solution containing a diphosphonate species;
 - (ii) agitative addition of a solution containing bismuth ions to said alkaline solution.
5. A process for making a particle containing a bismuth diphosphonate according to any of Claims 1 to 3 by agglomeration of an inorganic salt containing an anion capable of forming a bismuth salt with an alkaline bismuth diphosphonate solution.
6. A process according to Claim 5 wherein said bismuth salt is an insoluble salt.
7. A process according to either of Claims 5 or 6 wherein said inorganic salt is selected from the group consisting of the alkali and alkaline earth metal sulfates, and any mixtures thereof.
8. A process according to any of Claims 5 to 7 wherein said alkaline bismuth diphosphonate solution is made according to the process of Claim 4.

9. A process according to any of Claims 5 to 8 wherein an organic binder is included in the agglomeration step.
10. A bleaching composition comprising
 - (a) an oxygen-releasing bleaching system; and
 - (b) a bismuth diphosphonate compound according to any of Claims 1 to 3.
11. A bleaching composition according to Claim 10 wherein said bismuth diphosphonate compound is present in a particle obtainable by a process according to any of Claims 5 to 9.
12. A detergent composition comprising
 - (a) a detergent component selected from the group consisting of a water soluble builder compound, a low foaming surfactant system and any mixtures thereof; and
 - (b) a bleaching composition according to Claim 10.
13. A solid detergent composition according to Claim 12 obtainable by a process in which an alkaline bismuth diphosphonate solution is sprayed onto one or more of the other component parts of the composition.
14. A solid detergent composition according to Claim 12 containing a bleaching composition according to Claim 11.
15. A detergent composition according to any of Claims 12 to 14 wherein said bismuth diphosphonate compound is present at a level of from 0.005% to 20% by weight of the composition.
16. A detergent composition according to any of Claims 12 to 15 wherein said oxygen-releasing bleaching system comprises a hydrogen peroxide source and a peroxyacid bleach precursor compound.

17. A composition according to Claim 16 wherein said hydrogen peroxide source comprises an inorganic perhydrate salt.



The
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Office
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Application No: GB 9600553.3
Claims searched: 1-17

Examiner: Stephen Quick
Date of search: 22 March 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): C2P (P3B)

Int Cl (Ed.6): (not searched)

Other: Online: CAS ONLINE, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US4517060 (SCHERING), see columns 1 (lines 56-59) & 2 (lines 5-8 & 57-65)	1-17

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.